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PTO/SB/21 (12-97)
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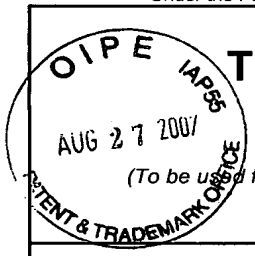


# TRANSMITTAL FORM

*(To be used for all correspondence after initial filing)*

| | |
|---|---|
| Application No. | 10/534,842 |
| Filing Date | May 13, 2005 |
| First Named Inventor | Tatu Pitkänen |
| Group Art Unit | 2855 |
| Examiner Name | O. Davis |
| Total Number of Pages in This Submission | |
| Attorney Docket Number | BERGPAT-8 |

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment / Response
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Response to Missing Parts/ Incomplete Application
  - ☐ Response to Missing Parts Under 37 CFR 1.52 or 1.53
- ☐ Assignment Papers *(For an Application)*
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition Routing Slip (PTO/SB/69) And Accompanying Petition
- ☐ To Convert a Provisional Application
- ☐ Power of Attorney, Revocation Change of Correspondence Address
- ☐ Terminal Disclaimer
- ☐ Small Entity Statement
- ☐ Request for Refund
- ☐ After Allowance Communication To Group
- ☐ Appeal Communication to Board Of Appeals and Interferences
- ☐ Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- ☐ Proprietary Information
- ☐ Status Letter
- ☒ Additional Enclosure(s) *(Please identify below):*
  - PTO SB/44
  - Request for Certificate of Correction

Certificate of Correction AUG 29 2007

Remarks

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**SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT**

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| Firm *or* Individual name | David R. J. Stiennon, Reg. No. 33212 |
| Signature | David R.J. Stiennon |
| Date | August 23, 2007 AUG 29 2007 |

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(Also Form PTO-1050)

# UNITED STATES PATENT AND TRADEMARK OFFICE
# CERTIFICATE OF CORRECTION

PATENT NO : 7,255,000
DATED : August 14, 2007
INVENTOR(S): Tatu Pitkänen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 2, line 55 of the issued patent, "states; and between" should be --states; where N is the number of states possible for each valve, and when the digital valve is driven between--

In column 2, line 65 of the issued patent "another. The" should be --another. Alternatively the--

In column 3, line 2 of the issued patent, "N3 states" should be --$3^{(\text{NUMBER OF VALVES})}$ states--

In column 3, lines 2-3 of the issued patent, after "states" delete --, in which N is the number of valves in the digital valve pack--

MAILING ADDRESS OF SENDER:

STIENNON & STIENNON
P.O. Box 1667
Madison, WI 53701-1667

PATENT NO. 7,255,000

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In The United States Patent And Trademark Office

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|---|---|---|---|
| Applicant: | Tatu Pitkänen et al. | Date: | August 23, 2007 |
| Date Filed: | May 13, 2005 | Docket No.: | BERGPAT-8 |
| App. No.: | 10/534,842 | Art Unit: | 2855 |
| Patent No.: | 7,255,000 | Issue Date: | August 14, 2007 |
| For: | A Method and an Arrangement for Controlling Position and/or Force of an Elongated Rolling Device | Examiner: | O. Davis |

Filed by Electronic Filing System

**Request for Certificate of Correction**
**With Expedited Processing**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicant requests that a Certificate of Correction be issued as shown on the PTO/SB/44 enclosed herewith.

This request for correction is incurred solely through the fault of the United States Patent and Trademark Office, as is clearly disclosed in the records of the Office. The accompanying documentation unequivocally supports this assertion of USPTO error, and includes copies of the relevant pages of the record, so that this request may be processed without the file. The relevant sections of the record have been highlighted in yellow.

Expedited processing is requested under the provisions of the August 21, 2002, Official Notice in 1262 TMOG 96.

Applicant respectfully requests that the typographical errors in the text of the published patent that were not in the original application be corrected by a Certificate of Correction under 37 CFR 1.322.

In column 2, line 55 of the issued patent, "states; and between" should be --states; where N is the number of states possible for each valve, and when the digital valve is driven between-- as written in the amendment dated March 6, 2007 on page 2, lines 3-4

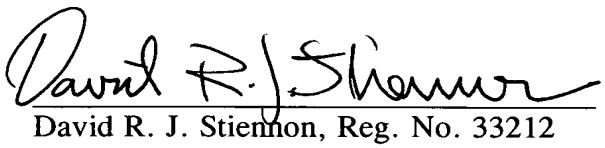
In column 2, line 65 of the issued patent "another. The" should be --another. Alternatively the-- as written in the amendment dated March 6, 2007, on page 2, line 12.

In column 3, line 2 of the issued patent, "N3 states" should be --$3^{(\text{NUMBER OF VALES})}$ states-- as written in the amendment dated March 6, 2007, on page 2, line 15.

In column 3, lines 2-3 2-3 of the issued patent, after "states" delete --, in which N is the number of valves in the digital valve pack--.

Applicant believes that these Office mistakes include at least one error of consequence that merits the issuance of a Certificate of Correction as it is of such a nature that the intended meaning may not be obvious from the context.

Respectfully submitted,



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Correct2.res/amdt

Relevant pages from printed U.S. Patent No. 7,255,000

# METHOD AND AN ARRANGEMENT FOR CONTROLLING POSITION AND/OR FORCE OF AN ELONGATED ROLLING DEVICE

## CROSS REFERENCES TO RELATED APPLICATIONS

This application is a U.S. national stage application of International App. No. PCT/FI2003/000860, filed Nov. 13, 2003, the disclosure of which is incorporated by reference herein. This application claims priority on Finnish App. No. 20022030, filed Nov. 14, 2002.

## STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

Not applicable.

## BACKGROUND OF THE INVENTION

The invention relates to a method and an arrangement for controlling the position and/or force of an elongated rolling device in the roll nip between two elongated rolling devices in paper and board machines.

The nip pressure in a roll nip between two rolls and the opening and closing of the roll nip are adjusted with hydraulic means connected to said rolls, such as hydraulic cylinders. For nip pressure control, suitable measuring means are first used for measuring the force/pressure generated by the roll in the roll nip, the control logic of the control system converts an analog measurement signal into a digital signal and transmits a control signal in digital form to the control valve in charge of changing the nip pressure. The digital control signal is converted into analog form by the control valve, and then the control valve controls the fluid flow entering and leaving the hydraulic means. Such a manner of controlling nip pressure has noticeable shortcomings, of which the major ones relate to disappearing data content as an analog measurement signal is converted into digital form and a digital control signal is subsequently converted into a control signal.

There are frequently also problems caused by the fact that the same relatively large-sized control valve, such as a proportional valve, is used for controlling both the force exerted by the roll on the backing roll in the roll nip between the rolls and also the roll position relative to the backing roll. This problem is particularly tangible in reelers, because, as the fiber web is reeled around the reel core, the reel core needs to be continuously shifted away from the reeling cylinder. However, meanwhile it is necessary to maintain the nip pressure between the reel core and the reel cylinder on a determined level. The shift of the location of the reel core requires relatively large movements of the piston of the hydraulic means and also changes of the fluid pressure prevailing in the compression cylinder, whereas changes of the nip pressure can be achieved with considerably smaller piston movements and changes of the fluid pressure in the compression cylinder, entraining a tendency to cause control fluctuation and vibrations in the roll/rolls. In practice, due to the great mass of the control valve and the consequently slow changes of the flow volume in the hydraulic means, it is often difficult or even impossible to actively attenuate roll vibrations caused by control fluctuation by means of control engineering means.

Controlling hydraulic means by current control valves such as servo valves and proportional valves is awkward and inaccurate, because the required valves are bulky and slow, and thus have poor control resolution. In addition, the control valves themselves might cause control fluctuation and vibrations in the rolling devices by their own operation.



The purpose of the invention is to eliminate the prior art inconveniences. Thus, the first purpose of the invention is to achieve a system for controlling the location and the force of the roll, allowing the same hydraulic means to accurately control both the location of the roll relative to the backing roll in the roll nip and also the nip pressure (=force) generated by the roll in the roll nip, substantially without control fluctuation. A second purpose of the invention is to achieve an active manner of control enabling efficient attenuation of roll vibrations.

## SUMMARY OF THE INVENTION

The invention relates to a method and to an arrangement for adjusting the location and/or force of an elongated rolling device in the roll nip between two elongated rolling devices.

The invention is based on the feature of controlling the nip pressure of a roll nip and the opening and closing of the roll nip with a hydraulic means, the volume flow arriving to the hydraulic means being at least partly controlled by a digital valve pack. The control signals utilized by the digital valve pack and transmitted by the control system are both in digital form, achieving the notable benefit over analog valves that control information does not require conversion from digital to analog form, so that no information will be lost while a digital control signal from the control system is converted into an analog control signal.

Use of the digital valve pack as switch means, allows very accurate control of the volume flow reaching the hydraulic means; thus, for instance, replacement of a large proportional valve with a digital valve pack containing 12 on/off digital valves provides a control resolution of 4096 different volume flows. What is more, on/off digital valves have markedly fast operation, so that the same digital valve pack allows control of the same hydraulic means both during shifts of the roll location, requiring large volume flow changes, while closing and opening of the roll nip, and also during changes of the nip pressure requiring relatively small volume flow changes.

In this patent application, at least one of the rolling devices in the roll nip between two elongated rolling devices is a roll used in paper and board machines, such as a calendaring roll or a reeler roll. The other of the rolling devices can then be a roll or an elongated roll-like array, such as a doctor blade, or the blade of a coating applicator used in fiber web coating, without being confined to these, however.

A digital valve stands for a valve having $N^{(NUMBER\ OF\ VALVES)}$ states; and between two successive states, the valve is driven directly from the first state to the second state.

The valve preferably has two states; it is either completely open or completely closed. When the valve is open, it is permeated by the entire volume flow rate of fluid allowed by this particular valve, and when the valve is closed, it is not permeated by fluid at all. In this application, a digital valve having two states is also referred to as an on/off valve and an on/off digital valve. A digital valve may have more than two states, and then the valve is driven stepwise from one state to another. The digital valve preferably has three positions; the valve transmits fluid flow into a first and a second direction, or then the valve does not transmit fluid. A

digital valve pack including such digital valves having three states then has $N^3$ states, in which N is the number of valves in the digital valve pack.

In the method of the invention for adjusting the location and/or force of an elongated rolling device in the roll nip between two elongated rolling devices in paper and board machines, the location of the rolling device relative to the other rolling device and/or the force exerted by the rolling device on another rolling device or any variable acting on these are measured, and the measured variable value is compared with the set value of said variable to obtain the difference value of the variable. The difference value is used for adjusting the location of the rolling device relative to the other rolling device and/or the force exerted by the rolling device on the other rolling device. The fluid pressure of the hydraulic means and/or the flow velocity of the liquid to the hydraulic means is altered in order to change the difference value by opening and/or closing at least one digital valve in a digital valve pack functionally connected to the hydraulic means.

The arrangement, in turn, includes a measurement means for measuring the location of the rolling device and/or the force it exerts on the other rolling device, or any variable acting on these, and for transmitting a measurement signal to the control system. The arrangement further comprises a hydraulic means, by means of which the location of the rolling device is shifted relative to the other rolling device and/or the force exerted by the rolling device on the other rolling device in the roll nip is changed, a switch means for adjusting the volume flow of the hydraulic means, a control system for receiving a measurement signal and for comparing the information in the measurement signal with the set value of the variable in order to provide a control signal and to transmit it to the switch means. The switch means has receive means for receiving and processing a control signal and also at least one digital valve pack, which comprises digital valves, preferably on/off digital valves, which can be switched on and off on the basis of a control signal, so that the fluid pressure of the hydraulic means and/or the flow velocity of the liquid to the hydraulic means change.

In a preferred embodiment of the invention, the fluid pressure of the hydraulic means and/or the flow velocity of the fluid to the hydraulic means is changed on the basis of a digital control signal from the control system by means of the digital valve pack, without converting the control signal into analog form in the meantime. Then the measurement means generates an analog measurement signal, on the basis of which the control system transmits a digital control signal to the digital valve pack that changes the flow rate and/or the fluid pressure of the hydraulic means.

In the invention, the control signals received and used by the digital valve pack are digital and the control signals from the control system to the digital valve pack are already in digital from, so that the control signal does not require conversion from digital form into analog form, as would be the case if the liquid flow of the hydraulic means were adjusted with an analog control valve. This achieves the marked advantage over analog valves, that control information cannot be lost between the control system and the switch means (digital valve pack).

In another preferred embodiment of the invention, the location of the rolling device in the roll nip and the force it exerts on another rolling device in the roll nip are adjusted by the same hydraulic means and the amount and velocity of said volume flow of the hydraulic means are changed by means of one or more digital valve packs.

In a further preferred embodiment of the invention, the measurement means performs measuring of the amplitude and frequency of the roll vibration and the control system determines the counter vibration for this rolling device vibration (difference value), on the basis of which selected digital valves in the digital valve pack are opened and closed. The counter vibration should be such that the amplitude of the measured roll vibration decreases towards its set value.

In the last mentioned embodiment of the invention, a digital valve pack allows for active vibration attenuation of the roll in a roll nip, unlike analog control valves. Using digital valves, the volume flow of the hydraulic means can be rapidly and accurately increased and decreased with good volume flow resolution, so that even minor vibrations in the roll nip can be attenuated. This offers the further potential feature of using the digital valve pack alongside a conventional analog control valve, such as a proportional valve; the control valve serves to open/close a roll nip between the rolling device and possibly also to control the nip pressure between two rolling device in the roll nip. The vibration of the rolling device in the roll nip is attenuated with active control operations by using digital valves alongside the analog valves mentioned above for controlling the volume flow to and from the hydraulic means.

The invention is described below in further detail with reference to the accompanying figures.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a roll nip between two rolls viewed from the end of the roll pair, and also the arrangement used for controlling the nip pressure in the roll nip.

FIG. **2** also shows a roll nip between two rolls viewed from the end of the roll pair, and the arrangement used for controlling the opening and the closing of the roll nip.

FIGS. **3**A and **3**E show a roll nip between two rolls viewed from the end of the roll pair. The figures illustrate the apparatus used for attenuating vibrations of the roll nip. FIGS. **3**B to **3**D show the attenuation of vibrations generated in the apparatuses by using the arrangement of the invention.

FIG. **4** is a schematic view of the roll nip between the reel cylinder of a reeler and the reel core, viewed from the end of the roll pair formed by the reel cylinder and reel core, and also the arrangement used for controlling the location of the reel core of the reeler and the nip force.

FIGS. **5**A and **5**B shows a roll nip viewed from the end of the pair of rolls in an apparatus used for fiber web coating, and the arrangement used for opening and closing the roll nip and for controlling the nip pressure.

FIG. **6**A is a schematic lateral view of a multi-zone roll and of the control arrangement used for pressurizing its different zones. FIG. **6**B shows an arrangement for controlling a multinip calender using the multi-zone roll of FIG. **6**A as the lowermost and the uppermost roll.

FIG. **7**A is a block view of the arrangement of the invention and FIG. **7**B is a block view of the method of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following examination starts with the main features of the designs and functions of the illustrated apparatuses and also the object to be illustrated by each figure.

FIG. **1** shows a simple roll nip N between the rolls of a pair **2** of two rolls, the nip pressure being controlled with the

Relevant page from amendment in U.S. Application No. 10/534,842,
filed on March 6, 2007

**In the specification:**

Please amend the specification as follows:

[0012] A digital valve stands for a valve having $N^{(\text{NUMBER OF VALVES})}$ states; where N is the number of states possible for each valve, and when the digital valve is driven between two successive states, the valve is driven directly from the first state to the second state.

[0013] The valve preferably has two states; it is either completely open or completely closed. When the valve is open, it is permeated by the entire volume flow rate of fluid allowed by this particular valve, and when the valve is closed, it is not permeated by fluid at all. In this application, a digital valve having two states is also referred to as an on/off valve and an on/off digital valve. A digital valve may have more than two states, and then the valve is driven stepwise from one state to another. Alternatively [[T]] the digital valve preferably has three positions; the valve transmits fluid flow into a first and a second direction, or then the valve does not transmit fluid. A digital valve pack including such digital valves having three states then has $3^{(\text{NUMBER OF VALVES})}$ [[$N^3$]] states~~, in which N is the number of valves in the digital valve pack~~.